REMARKS

Applicants hereby request further consideration of the application in view of the following comments. No amendments to the claims or the specification have been made in the present response.

I. THE PENDING REJECTIONS

Claims 1-5, 7-12, 14-17, 20, 23-24, 26-33, 35-36 and 46-47 stand rejected under 35 U.S.C. § 103(a) as being unpatentable over Pinkahsov (U.S. Patent No. 4,978,556) in view of Davis (U.S. Patent No. RE 34,861) and Kuehnle (U.S. Patent No. 5,879,518). Claims 1-5, 7-12, 14, 17-20, 23-24, 26-30, 32-33, 35-36 and 46-47 stand rejected under 35 U.S.C. § 103(a) as being unpatentable over Pinkahsov in view of Davis and Smalley (U.S. Patent No. 5,227,038). Claim 13 stands rejected under 35 U.S.C. § 103(a) as being unpatentable over Pinkahsov in view of Davis, Jaussaud (U.S. Patent No. 6,113,692), and Kuehnle or Smalley. Claims 18-19 stand rejected under 35 U.S.C. § 103(a) as being unpatentable over Pinkahsov in view of Davis, Kuehnle and Fey (U.S. Patent No. 4,582,004). Claims 21-22 stand rejected under 35 U.S.C. § 103(a) as being unpatentable over Pinkahsov in view of Davis, Kuehnle or Smalley and Otsuki (U.S. Patent No. 6,090,733). Finally, Claims 22 and 48 stand rejected under 35 U.S.C. § 103(a) as being unpatentable over Pinkahsov in view of Davis, Kuehnle or Smalley and Kijima (U.S. Patent No. 5,093,039).

II. RESPONSE TO THE PENDING REJECTIONS

A. The Rejections Should Be Withdrawn Because Pinkahsov Does Not Teach Growing Silicon Carbide Via Sublimation

As an initial matter, the pending rejections should be withdrawn because Pinkahsov does not teach using **a sublimation system** to grow silicon carbide using electric arc vapor deposition techniques. Sublimation refers to a process where a solid is heated directly to a gaseous state and the resulting vapors are condensed back into solid form. (*See* Webster's Dictionary at 1418, defining sublimate and sublime, attached as Ex, A hereto). All of the pending claims are directed to methods of growing silicon carbide in "a sublimation system." (*See, e.g.*, Claim 1, stating

"introducing a silicon carbide electrode into the sublimation system"). Pinkahsov, however, is directed to an arc vapor deposition technique in which molten (*i.e.*, material that has been "melted or liquefied by heat") material is vaporized for purposes of growing a material on a substrate. (*See* Pinkahsov at Col. 2, lines 34-35; Col. 3, lines 49-54; Col. 4, lines 33-34; *see also* Webster's Dictionary at 916, Ex. A). In this regard, Pinkahsov expressly refers to a series of related patents and applications as describing the details regarding "[t]he formation of vapor and its deposition upon the substrate 23." (Pinkahsov at Col. 3, lines 54-57). These prior patents to Pinkahsov make clear that the Pinkahsov process involves two phase transformations – solid to liquid and liquid to gas:

> Generally speaking, a body of the material to be transferred to the substrate is heated in the region of this substrate and transformed first into a molten state and then into a vapor state. The material thus undergoes two phase transformations, namely, the transformation from the solid phase to the liquid phase and then from the liquid phase to the vapor phase.

(U.S. Patent No. 4,505,948 to Pinkahsov at Col. 1, lines 42-48). The patents go on to explain that the vapor deposition proceeds by striking an electric arc between the pool of molten material and an electrode:

> This application discloses a method of vapor-depositing material upon a substrate which, as indicated, utilizes an electrical arc struck between a pool of molten material and a counterelectrode, thereby vaporizing the material on the surface of the pool and permitting transfer of the vaporized material in the vapor state to the substrate.

(*Id.* at Col. 2, lines 13-17). Thus, as Pinkahsov does not teach or suggest growing silicon carbide **via sublimation** using a silicon carbide electrode as recited in all of the pending claims, the rejections of the pending claims should be withdrawn.

B. Pinkahsov Does Not Enable Arc-Vapor Deposition Using a Silicon Carbide Electrode

The rejections of all the pending claims should likewise be withdrawn because Pinkahsov does not enable a person of skill in the art to perform electric arc vapor deposition using a silicon carbide electrode. As noted above, Pinkahsov discloses an arc vapor-deposition method in which an arc is struck between a molten pool of

electrode material and a second electrode. The example in Pinkahsov describes use of two silicon electrodes. While Pinkahsov also states that arc vapor-dposition may be used to deposit silicon carbide on a substrate, the prior patents cited in Pinkahsov teach that silicon carbide is deposited on the substrate by using a silicon electrode and a carbon block electrode which contains "a molten pool of silicon and solubilized carbon." (*See* U.S. Patent No. 4,505,948 to Pinkahsov at Col. 6, lines 60-63 and Col. 7, lines 36-40). Such a molten pool of silicon and solubilized carbon is not a silicon carbide electrode as recited in the pending claims.

More importantly, it is clear that the process of Pinkahsov **would not work** with a silicon carbide electrode. Pinkahsov teaches that the process is carried out under vacuum conditions (*i.e.*, at pressures of 10^{-3} torr or better). (Pinkahsov at Col. 3, lines 66-68). As shown in the references attached at Ex. B hereto, silicon carbide **does not form a liquid state at those pressures** (*See*, e.g., Seace and Slack, Solubility of Carbon in Silicon and Germanium at 1554). Accordingly, the method of Pinkahsov where the arc vapor deposition is carried out between an electrode and a pool of molten material in a second electrode will not work with silicon carbide electrodes. Thus, because Pinkahsov does not enable an arc vapor-deposition process that uses a silicon carbide electrode, the rejections of all the pending claims should be withdrawn.

C. The Rejections Should Be Withdrawn Because There is No Motivation To Combine Kuehnle or Smalley with Pinkahsov and Davis

To establish a *prima facie* case of obviousness, the combination of prior art references must teach or suggest all the recitations of the claims **and** there must be some suggestion or motivation, either in the references themselves or in the knowledge generally available to one of ordinary skill in the art, to combine the reference teachings to arrive at the claimed invention. M.P.E.P. § 2143. The mere fact that references can be combined or modified does not render the resultant combination obvious unless the prior art also suggests the desirability of the combination. M.P.E.P. § 2143.01, citing *In re Mills*, 916 F.2d 680, 16 U.S.P.Q.2d

1430 (Fed. Cir. 1990). As emphasized by the Court of Appeals for the Federal Circuit, to support combining references, evidence of a suggestion, teaching, or motivation to combine must be **clear and particular**, and this requirement for clear and particular evidence is not met by broad and conclusory statements about the teachings of references. *In re Dembiczak*, 50 U.S.P.Q.2d 1614, 1617 (Fed. Cir. 1999). The Court of Appeals for the Federal Circuit has also stated that, to support combining or modifying references, there must be **particular** evidence from the prior art as to the reason the skilled artisan, with no knowledge of the claimed invention, would have selected these components for combination in the manner claimed. *In re Kotzab*, 55 U.S.P.Q.2d 1313, 1317 (Fed. Cir. 2000).

In the present case, Applicant submits that the Office Action fails to provide the necessary showing that a skilled artisan would have been motivated to combine either Kuehnle or Smalley with Pinkahsov and Davis as is done in all of the pending rejections. The lack of any such evidence of motivation to combine the references in the manner of the rejections provides an independent basis for withdrawal of each of the pending rejections.

In the portion of the Office Action detailing the rationale for the pending rejections, the Office Action conclusively states that "[i]t would have been obvious to a person of ordinary skill in the art at the time of the invention to modify the combination of Pinkahsov and Davis et al with Kuehnle to vaporize the electrode material at a steady level (col. 4, ln 15-25), thereby avoiding undesired changes in flux resulting in uniform polytype." (Office Action at 4). With respect to the rejections that rely on Smalley, the Office Action similarly states in a conclusory fashion that "[i]t would have been obvious to a person of ordinary skill in the art at the time of the invention to modify the combination of Pinkahsov and Davis et al with Smalley's means for maintaining a desired gap for the electrical arc to maintain an optimum length of the arc gap during the entire process." (Office Action at 6). Notably the Office Action does **not** point to anything in the cited references or the art as a whole in support of these statements. Applicant respectfully submits that the *Dembiczak* decision of the Federal Circuit discussed above holds that the conclusory

and unsupported statement of motivation to combine provided in the Office Action cannot, as a matter of law, support an obviousness rejection under 35 U.S.C. § 103.

Applicant's May 1, 2003 submission discussed how the initial Office Action likewise failed to provide a showing that the skilled artisan would have been motivated to combine Kuehnle or Smalley with Pinkahsov and Davis. In response to Applicant's arguments, the current Office Action states that Kuehnle, Smalley and Pinkahsov teach different methods for vaporizing electrode material and that it "would have been obvious to a person of ordinary skill in the art at the time of the invention to use [the] alternative method of vaporizing electrode material [of Kuehnle], where the material is vaporized steadily." (Office Action at 12). Applicant respectfully submits that this additional statement likewise is not a sufficient showing of motivation to combine for at least three reasons.

First, under controlling Federal Circuit precedent, a rejection under 35 U.S.C. § 103 must include citation to **particular** evidence from the prior art showing the reason that a skilled artisan, with no knowledge of the claimed invention, would have combined components from the cited references in the manner claimed. *In re Kotzab*, 55 U.S.P.Q.2d 1313, 1317 (Fed. Cir. 2000). The Office Action, however, **fails to identify any teaching in the art** that suggests modifying the Pinkahsov process to incorporate the Kuehnle or Smalley mechanisms for maintaining a constant gap between the electrodes, and instead just conclusively states that it would have been obvious to do so. This is exactly the type of statement that the Federal Circuit has found is not sufficient to qualify as a showing of the motivation to combine the cited references. *Dembiczak*, 50 U.S.P.Q.2d at 1617.

In any event, a review of the cited art makes clear that the requisite evidence of motivation to combine Pinkahsov with Kuehnle or Smalley simply does not exist. Kuehnle is directed to a method and apparatus for "producing small particles, e.g., nanoparticles, which have consistent size, shape, structure and functionality." (Kuehnle at Col. 1, lines 6-10). In order to facilitate collection of particles of different sizes in different collection bins Kuehnle maintains a substantially constant energy flow between the electrodes so that the electrode material vaporizes at a steady level.

(Kuehnle at Col. 4, lines 18-21). Smalley is directed to a method of producing fullerenes particles, and has nothing to do with the use of silicon carbide electrodes or electric arc sublimation of silicon carbide. Thus, the reason motivating Kuehnle and Smalley to use the particular methods disclosed therein have no relevance whatsoever to Pinkahsov which is directed to growing semiconductor materials on a substrate. Thus, a skilled artisan would not have been motivated to modify Pinkahsov to use the electrode apparatus of Kuehnle or Smalley.

Second, and more importantly, **Pinkahsov teaches directly away from using the electrode apparatus disclosed in Kuehnle or Smalley**. Specifically, Pinkahsov teaches that "arc vapor deposition" of silicon or silicon carbide onto a substrate is accomplished by repeatedly striking the two electrodes together and then separating the electrodes to form an arc between them. (Pinkahsov at Col. 1, lines 34-45 and Co. 3, lines 49-60). In the example set forth in Pinkahsov, an arc is formed approximately one time per second through this intermittent movement of one or both of the electrodes. (Pinkahsov at Col. 4, lines 27-28). As explained in one of the earlier patents that Pinkahsov references as describing aspects of his invention:

> I may move the counterelectrode into and out of contact with the pool to thereby deposit some of the melt upon the counterelectrode and permitting the heat generated at the electrode tip to vaporize at least in part the material transferred to it and thus in part generate the vapors which are to be transferred to the substrate.

(U.S. Patent No. 5,505,948 at Col. 2, lines 30-36). This prior Pinkahsov patent goes on to state:

> Surprisingly, once the arc is struck as the two electrodes are separated, the arc, a portion of the arc or a heating effect generated by the arc appears to spiral around the long electrode and cause vaporization of the material of the electrode in a generally helical or spiral pattern progressively moving away from the counterelectrode.
>
> It is indeed a remarkable surprise that the arc is not confined to the space between the two electrodes but rather has a component or an effect which spirals away from the counterelectrode toward a region of the length of the long electrode which is further removed from the counterelectrode in spite of the fact that the greatest conductivity would appear to lie in a line directly between the two electrodes where the major portion of the arc appears to be

> confined. This effect is manifest in the fact the long electrode, i.e. the deposition electrode, while originally of uniform cross section, develops a taper toward the counterelectrode and coating from the blank of the deposition electrode onto the substrate can be observed at considerable distance from the arc's striking face of the deposition electrode.
>
> In fact, the effect appears to survive for a brief period following extinction of the original arc and hence I prefer to periodically contact and separate the electrodes to generate the arc and then allow extinction thereof.

(U.S. Patent No. 5,505,948 at Col. 4, lines 16-42). Thus, it is clear that a critical part of the invention of Pinkahsov involves moving the electrodes into and out of contact with each other – in other words, **not** maintaining a constant gap – as this is required both to (1) facilitate vaporization of the electrode material in the molten pool by depositing that material onto the tip of the counterelectrode and (2) to induce an effect whereby the arc is formed not only between the two electrodes, but also along the length of the deposition electrode.

In light of these teachings in Pinkahsov, Applicant respectfully submits that a skilled artisan would not have been motivated to combine either Kuehnle or Smalley with Pinkahsov as doing so would be **directly contrary** to the teachings of Pinkahsov. Applicant notes that the July 8, 2003 Office Action nowhere addresses Applicant's previous showing that the Pinkahsov reference teaches away from the combination of references cited in the pending rejections. Applicant respectfully submits that this teaching away from the combination of references cited in the pending rejections compels withdrawal of those rejections.

Finally, the rejections should also be withdrawn because neither Kuehnle nor Smalley are analogous art. The grounds for this objection to the pending rejections is set forth fully in Applicant's May 1, 2003 submission and hence will not be repeated here.

D. Claims 33, 35 and 36 are Independently Patentable Over the Cited Art

Claims 33, 35 and 36 recite that the electric arc is used to "create a local high temperature zone within the furnace . . . while maintaining the inner walls of the furnace at a temperature below the temperature at which silicon carbide sublimes."

Applicant respectfully submits that none of the cited references teach or suggest "using resistive or inductive heating to heat a furnace" while at the same time "creat[ing] a local high temperature zone within the furnace . . . while maintaining the inner walls of the furnace at a temperature below the temperature at which silicon carbide sublimes." (*See* Claim 33). This argument was raised in Applicant's May 1, 2003 submission in response to similar rejections. In response to that argument, the present Office Action does state that "the combination of Pinkahsov, Davis and Kuehnle teaches an electric arc [and thus] reads on applicant's local high temperature zone," but conspicuously absent is any indication that the cited art teaches creating the local high temperature zone "while maintaining the inner walls of the furnace at a temperature below the temperature at which silicon carbide sublimes" as recited in Claims 33, 35 and 36. Applicant respectfully submits that the failure of the current Office Action to address Applicant's showing that the full recitation of Claim 33 is not taught by the cited art shows precisely why Claims 33, 35 and 36 should be allowed.

In any event, as Applicant has previously shown that:

- Davis teaches heating the furnace walls to a temperature **above** the temperature at which silicon carbide sublimes. (*See, e.g.,* Davis at Col. 11, lines 20-23).
- Pinkahsov does not teach or suggest that a furnace is even provided, as the electric arc is used solely to perform the vaporization. (*See* Pinkahsov at Col. 4, lines 5-41).
- Kuehnle teaches that a "cold" inert gas is flowed just inside the housing sidewall, indicating that in Kuehnle the housing is actually cooled as opposed to heated. (*See* Kuehnle at Col. 4, lines 3-12).

This showing that the cited art does not teach the invention of Claims 33, 35 and 36 is unrebutted. Accordingly, Applicant respectfully requests that the rejections of Claims 33, 35 and 36 be withdrawn for this additional reason or else that the Examiner specifically identify the portions of the cited references that allegedly teach "creat[ing] a local high temperature zone within the furnace . . . while maintaining the

inner walls of the furnace at a temperature below the temperature at which silicon carbide sublimes."

E. Other Arguments That The Office Action Fails to Address

Applicant's May 1, 2003 submission likewise explained how the cited references failed to teach or suggest the recitations of dependent Claims 11, 12 and 15. Notably, the pending Office Action fails to respond to Applicant's arguments and likewise fails to even mention Claims 11, 12 and 15 other than to state without any support or explanation whatsoever, that those claims are rejected under 35 U.S.C. § 103. Applicant, therefore, requests that Claims 11, 12 and 15 be indicated as allowable or that alternatively the Examiner indicate specifically where in the cited references he finds his basis for rejecting these claims.

F. Claims 14 and 30 are Independently Patentable Over the Cited Art

Claim 14 recites that "the internal temperature of the sublimation system, the position of the silicon carbide electrode and the second electrode, a voltage drop across the gap and a current conducted across the gap are configured so as to maintain the end of the silicon carbide electrode adjacent the gap at a substantially constant temperature during the sublimation process." Claim 30 contains a similar recitation. While the Office Action states that the combination of Pinkahsov and Davis in view of either Kuehnle or Smalley teaches these recitations, Applicant respectfully disagrees. Pinkahsov discloses a process where the temperature at the end of the electrode will vary (*i.e.*, not remain constant), and Davis teaches that the temperature of the silicon carbide source material is varied throughout the sublimation process. The Kuehnle and Smalley references are silent regarding the temperature at the end of the electrode, and hence do not provide the necessary teaching. In any event, even if Kuehnle or Smalley taught the recitations of Claims 14 and 30, no motivation has been identified for modifying the primary references – each of which teach away from maintaining the ends of the electrodes at a constant temperature – in this manner. Accordingly, Claims 14 and 30 likewise are independently patentable over the cited art for at least these additional reasons.

III. CONCLUSION

Applicant submits that the present application is in condition for allowance and the same is earnestly solicited. Should the Examiner have any matters outstanding of resolution, he is encouraged to telephone the undersigned at 919-854-1400 for expeditious handling.

Respectfully submitted,

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CERTIFICATE OF FACSIMILE TRANSMISSION

I hereby certify that this correspondence is being sent via facsimile transmission to (703) 872-9311, Group Art Unit: 1765 at Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450, on September 8, 2003.

Michele McMahan
Date of Signature: September 8, 2003
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